

THE WEATHER AND CIRCULATION OF FEBRUARY 1964

Another Cold Month in the South

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1. HIGHLIGHTS

This was a cold month from coast to coast in the United States except for Montana and most of the North-Central States. Because of the absence of severe Arctic outbreaks, the cold was generally not extreme, but it was very persistent in parts of the West and South. As a result, February averaged the coldest on record at Santa Maria, Calif., Pocatello, Idaho, Albuquerque, N. Mex., El Paso, Tex., and New Orleans, La. Influenced by almost cloudless skies in the Far West, average minimum temperatures were the lowest of any February at Fresno, Calif., Medford, Oreg., and Winslow, Ariz.

Foehn conditions were well developed during the month in Montana, where Havre had the windiest February on record since 1879, and temperatures averaged 31.8° F. or 15.5°F. above normal. This made a striking contrast to the west side of the Continental Divide, where temperatures at Pocatello, Idaho, averaged 16.9°F., or 10.3°F. below the February normal.

It was one of the driest and sunniest Februarys ever recorded west of the Continental Divide. Sexton Summit, Oreg., Mt. Shasta and Blue Canyon, Calif., Olympia, Wash., Ely, Nev., and Boise, Idaho, all reported the least precipitation ever measured in February. No measurable amounts fell at Los Angeles, Calif., or El Paso, Tex., equaling earlier records. Record hours of sunshine occurred throughout California and many other parts of the Far West. This was also one of the driest Februarys on record over large areas of the Upper Mississippi and Missouri Valleys and the Great Lakes Region. Subnormal precipitation extended the drought in Ohio to 14 consecutive months at Cleveland, 11 at Akron, and 6 at Columbus.

Snowfall was above the February average at many places in the East. It ranged to four times the February average at Beckley, W. Va., and Asheville, N.C., while record amounts for February occurred at Elkins and Charleston, W. Va. Near record snowfall also fell in eastern Pennsylvania where 20.8 in. occurred in 39 hours at Harrisburg on February 18-20.

It was wet in the Southeast; Jacksonville, Fla., received 6.55 in., more than twice the normal rain, and Atlanta, Ga., reported about twice the usual number of rainy days.

2. MEAN CIRCULATION

The circulation at 700 mb. during February (fig. 1) was characterized by abnormally strong ridges near their normal positions along the west coasts of North America and Europe, and also in central Asia. Troughs also were abnormally developed and in their normal locations near the east coast of North America and in Central Europe, but the Pacific trough was about 20° of longitude east of normal. The strength of the ridges is evident from the height departures from normal (fig. 2) of about 500 ft. in Asia and the eastern Pacific. The latter, together with negative departures in the United States, and the blocking pattern of positive departures near Iceland and negative departures near the Azores, comprised a circulation anomaly that has occurred often in recent months, notably January, June, and December of 1963.

At sea level (fig. 3) the Atlantic mean Low was about 750 mi. southwest of normal, and about 9 mb. deeper than normal. The High near Lake Baikal was probably the strongest on record, with an average central pressure of 1047.5 mb. for the month. This was about 12.5 mb. greater than normal, over 2.5 standard deviations. Contributing to this average were the highest daily pressures, reduced to sea level, ever reported anywhere, notably 1076 mb. at Ulanom, Mongolia, and 1078 mb. at an unidentified station nearby on February 14, exceeding the former record of 1075.2 mb. at Irkutsk, Siberia, on January 14, 1893.

The mean jet axes at 700 mb. (fig. 4) reflected the amplified character of the monthly circulation. In the ridge areas they were north of their usual positions, and in the trough regions they were south of normal. In the eastern Atlantic the usual single axis near the northern tip of Scotland was split into two branches by persistent blocking, with one branch over Greenland and another near the Azores. Near North America the principal tracks of sea level disturbances were closely related to the jet axes and about 5° to the north, the usual relationship. A northern series of cyclones of the "Alberta" type followed a track from the south coast of Alaska toward the Great Lakes, while a series of southern Lows developed in the Gulf of Mexico and then traveled northeastward between the jet axis and Newfoundland. A few emerged from the Plains

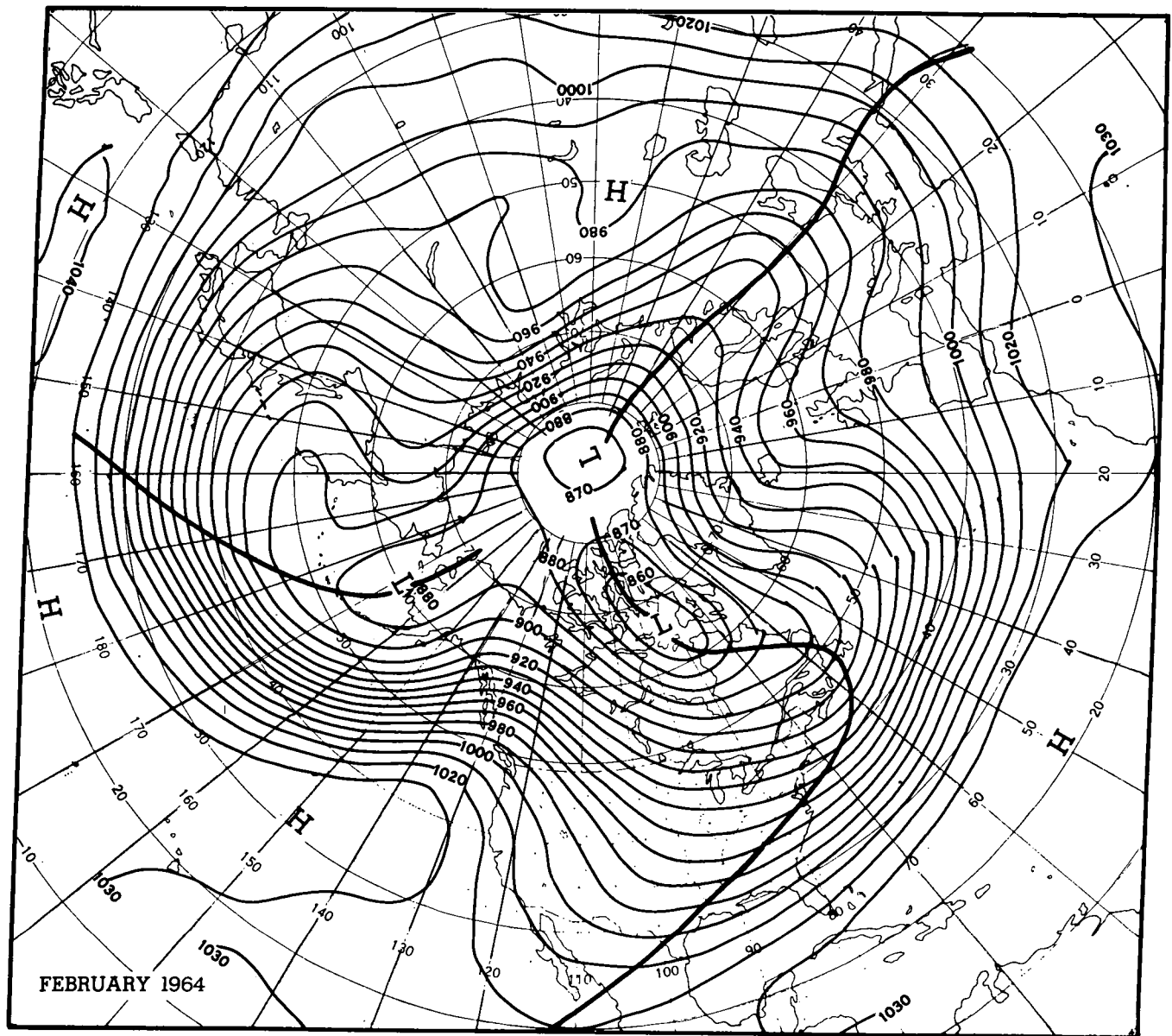


FIGURE 1.—Average 700-mb. contours (tens of feet) for February 1964. Except for the Pacific trough, planetary waves were near their normal positions but strongly amplified.

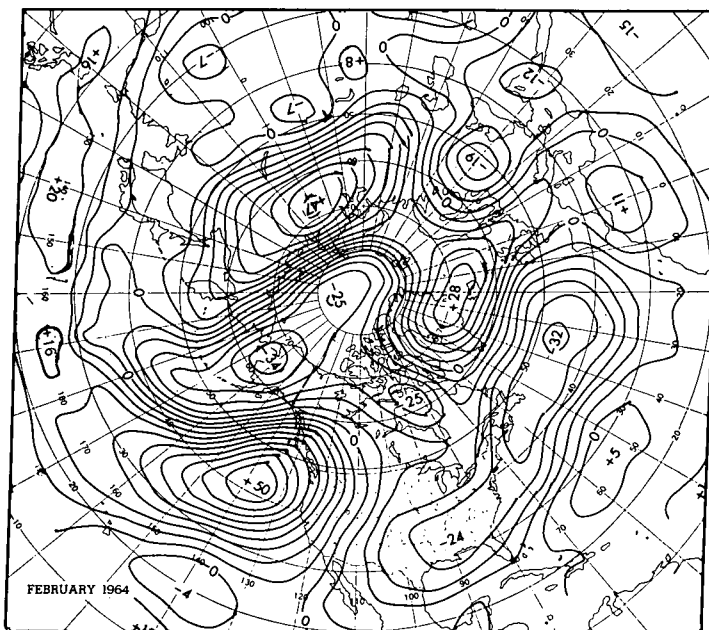


FIGURE 2.—Average 700-mb. height departures from normal (tens of feet) for February 1964. Persistent positive departures in eastern Pacific contributed to cold weather.

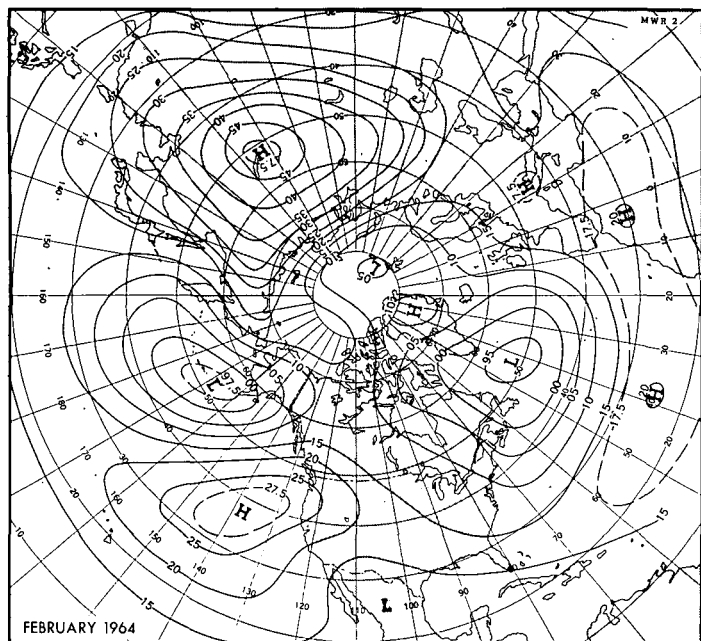


FIGURE 3.—Average sea level isobars (mb.) for February 1964. Outstanding feature was the record strength of the Siberian High.

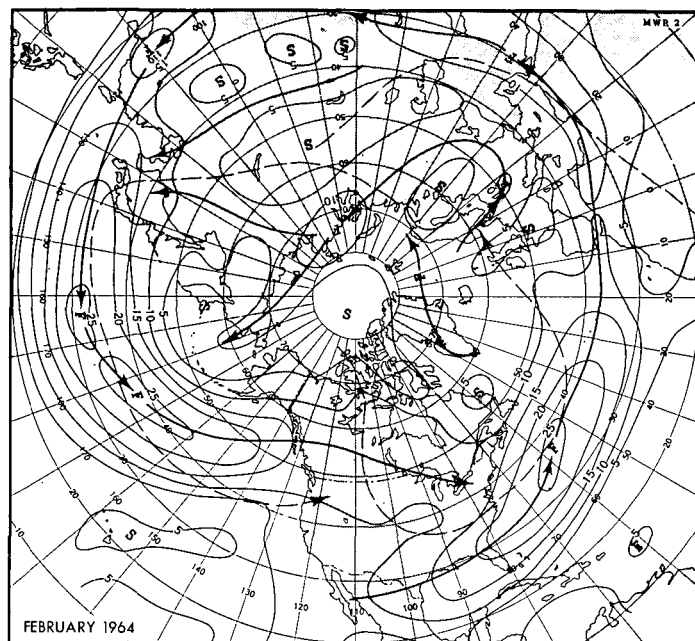


FIGURE 4.—Mean isotachs (meters per second) at 700 mb. for February 1964. Solid arrows indicate axes of maximum wind speed, dashed arrows the normal. Axis along the Gulf Coast was unusually far south, in accord with the cold wet weather in the Southeast.

on tracks which converged across Kentucky and Virginia.

During February the speed of the mid-latitude westerlies at 700 mb. (fig. 5) continued an interesting 14-day oscillation that started in January. This oscillation was also evident in weekly alternations of positive and negative height departures from normal in the North Atlantic, Canada, and the western United States, shown in figures 7A, 8A, 9A, and 10A.

3. TEMPERATURE

The warmth in Montana and the North Central States (fig. 6A) was characterized by great persistence (every day warmer than normal at Glasgow, Mont.) instead of by extremes, as few new daily records were established. The warmth was aided by foehn winds which were maintained by a steady succession of "Alberta" disturbances associated with the zonally oriented jet axis in western Canada (fig. 4), and the high pressure in the Pacific Northwest (fig. 3) which averaged about 8 mb. above normal near the coast. The absence of Arctic outbreaks, which also contributed to the warmth in the north, was in accord with the absence of the usual meridional jet axis in Canada during February. These factors were in harmony with the strong westerly jet in the Gulf of Alaska which resulted from subnormal heights over Alaska, and supernormal heights in the eastern Pacific (fig. 2). The deep trough near the Bering Strait also served to divert cold air from Siberia into the Bering Sea instead of into western Canada, the more usual path in February. This was one of the essential differences which kept the weather mild in the northern States this month in contrast to January

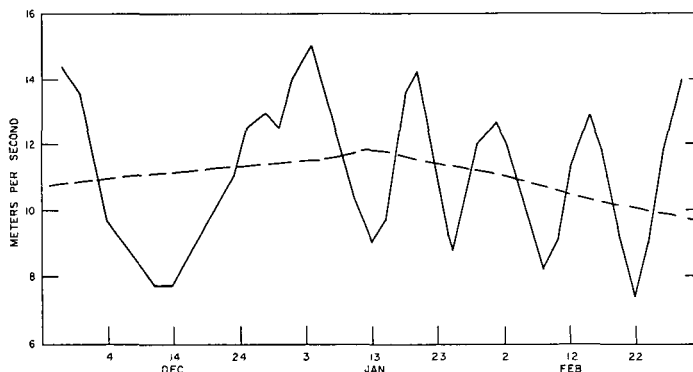


FIGURE 5.—Variation of 5-day average wind speeds (meters per second) at 700 mb. for western half of Northern Hemisphere, from 35°N. to 55°N. from December 1963 to February 1964 (solid) in comparison with corresponding normal variation (dashed). Most interesting was the approximately 14-day periodicity in January and February.

1963 [1] and December 1963 [2] which had otherwise similar circulation anomalies.

In other parts of the United States, the temperature regime was far different (fig. 6A). The cold in the South and West was not of extreme severity, as indicated by a scarcity of new records for daily temperature. However the cumulative effect of persistent cold this February established new records for the month as a whole in a number of areas including the cities mentioned earlier.

The cold weather in the West and South was maintained

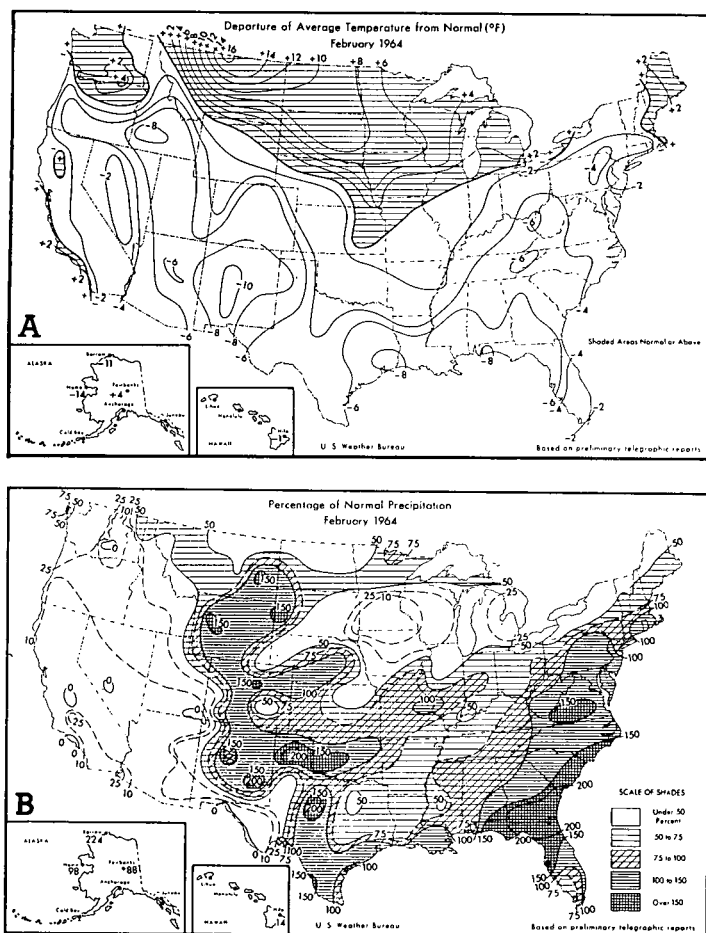


FIGURE 6.—(A) Temperature departure from normal (°F.) and (B) percentage of normal precipitation, for February 1964. (From [3].)

by a series of cold pools associated with upper-level disturbances which plunged repeatedly and in rapid succession from western Canada across Idaho, Utah, and New Mexico, in response to large-scale steering by the high pressure circulation in the eastern Pacific. They then traveled eastward to the Virginia coast. The upper disturbances usually broke away, over southwestern Canada, from parent disturbances which traveled eastward on the northern track toward the Great Lakes, in support of the "Alberta" surface systems.

4. PRECIPITATION

Precipitation in February (fig. 6B) was heavier than normal near the Continental Divide in association with upper disturbances which traveled southeastward repeatedly over the eastern Rockies. West of the Divide extreme dryness resulted from the absence of upward motions implied by the strong anticyclonic vorticity of the circulation at all levels, as well as its departure from the normal.

From the western Plains to the Appalachians precipitation was mostly less than normal, with near record dryness in the Upper Mississippi Valley and Great Lakes regions.

Those areas were largely under the influence of dry Pacific air south of the "Alberta" disturbances related to the northern jet axis.

Near the Gulf coast rainfall was heavy in places, especially in the Southeast, where frontal disturbances were induced by the vorticity maxima aloft which migrated from the southern Rockies along the jet axis near the coast. Intensification of some of the disturbances in proximity to an abundant source of moisture brought 11.50 in. of rain, including 5.59 in. on the 27th, to Tallahassee, Fla., for the largest February total since 1914.

Farther north, heavy to record amounts of snow fell in some parts of the East as the frontal disturbances and their counterparts aloft developed closed circulations. Also of importance in producing snowfall was the abnormal position of the Atlantic Low off Newfoundland which helped keep temperatures in the East colder than normal by steering cold Highs southward over the middle Atlantic States.

5. WEEKLY EVOLUTION

The upper circulation in the first week was characterized by a sharp decline in the zonal index at 700 mb. (fig. 5), with heights above normal in the Northwest and sub-normal in the Southeast (fig. 7A). Below normal heights over Alaska and the Yukon favored higher than normal temperatures (fig. 7B) over much of the country except in the West and Gulf States where cold pools associated with upper-level disturbances kept temperatures below normal. The most vigorous of these was a deep cold upper Low which plunged southward across the Rockies. It brought snow which ranged from 6 in. in New Mexico to more than 2 ft. in parts of the Texas and Oklahoma Panhandles, including 17 in. at Amarillo on February 3 and 4, and later heavy rains to the rest of the South and East (fig. 7C). Snows of up to 11 in. fell locally near the Great Lakes on February 7–8 associated with another upper Low.

In the second week blocking relaxed as heights fell over North America (fig. 8A) and the zonal index rose sharply (fig. 5). The abnormal warmth in the North Central States and the cold in the West continued, but it became colder in the South and East (fig. 8B). Upper-level disturbances crossing the Washington coast brought heavy precipitation to the Northwest from February 10 to 14 (fig. 8C). They then swept eastward, producing almost daily precipitation in the South and East. Snowfalls of 6 to 9 in. accompanied one disturbance on February 10–11 in Missouri, Kentucky, West Virginia, Pennsylvania, Delaware, and New Jersey. Another on February 12–13 brought 6-in. snowfalls to Iowa, Illinois, Michigan, and Ohio. Still another from February 14 to 16 brought snows ranging from 4 in. in Kansas and Nebraska to 6 in. from Missouri to Virginia and to 10–14 in. in New York and New England, where Pittsfield, Mass., received 14.3 in. on the 16th.

In the third week the zonal index plunged sharply

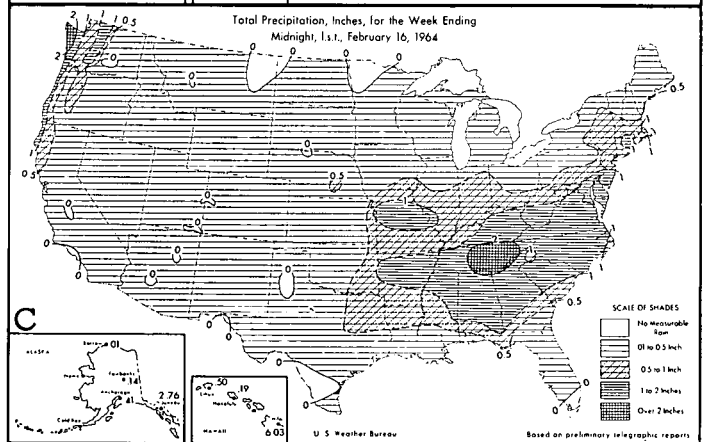
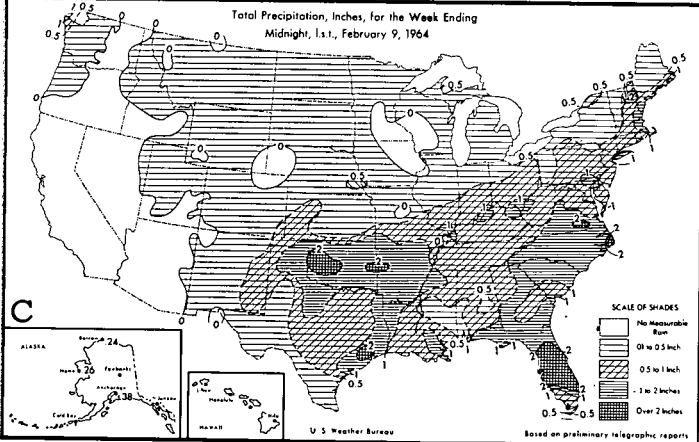
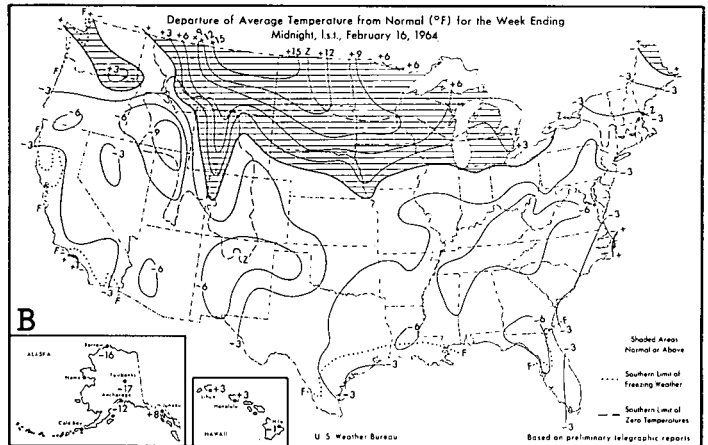
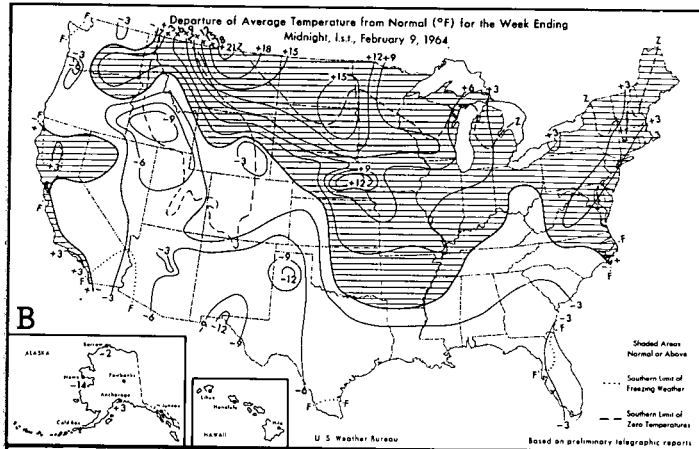
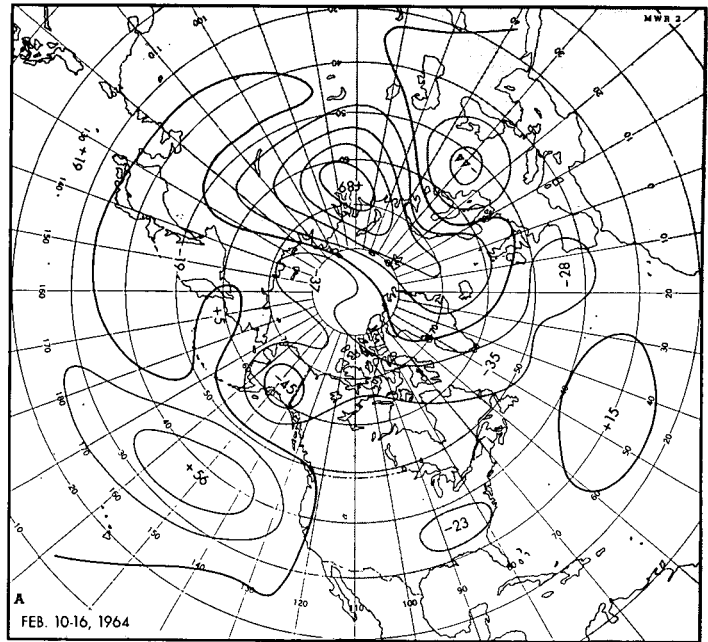
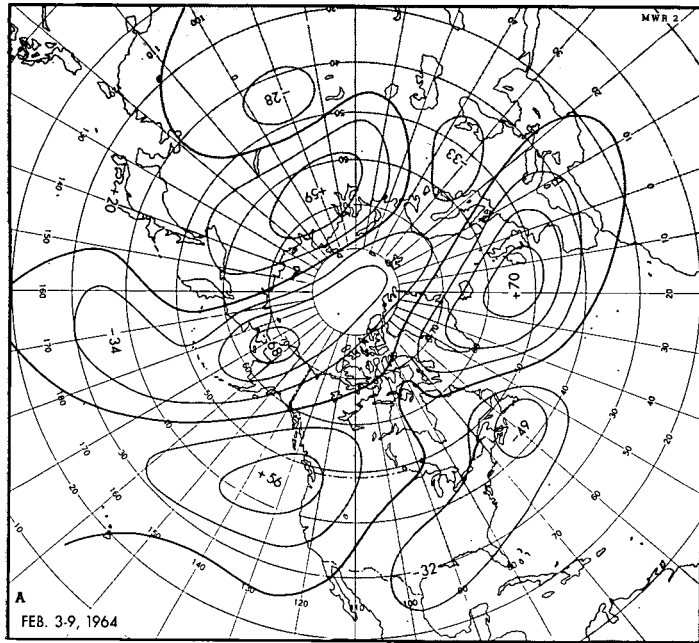


FIGURE 7.—Average departures from normal for February 3–9, 1964 of (A) 700-mb. height (tens of feet), (B) temperature (°F.), and (C) total precipitation (inches). (B) and (C) from [3].

FIGURE 8.—Same as figure 7 for February 10–16, 1964.

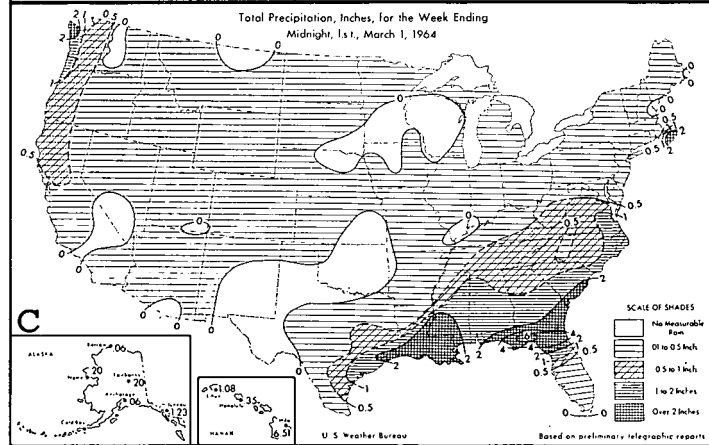
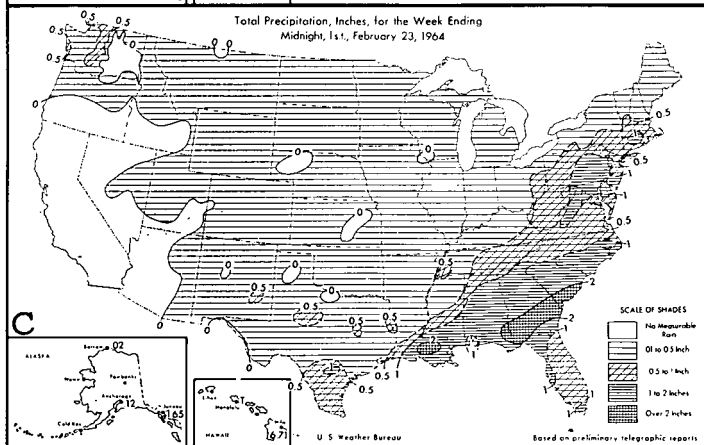
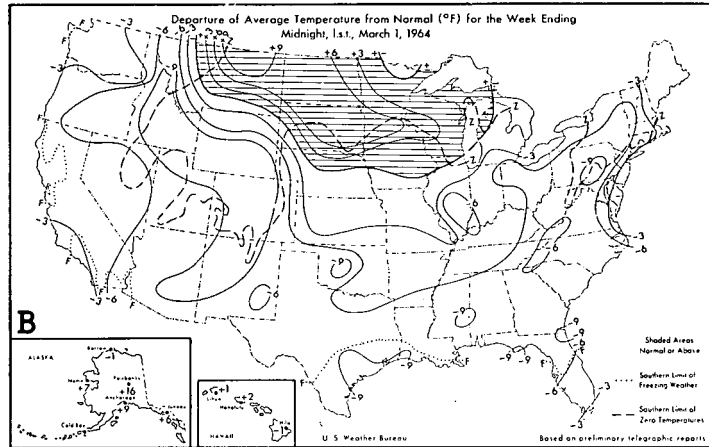
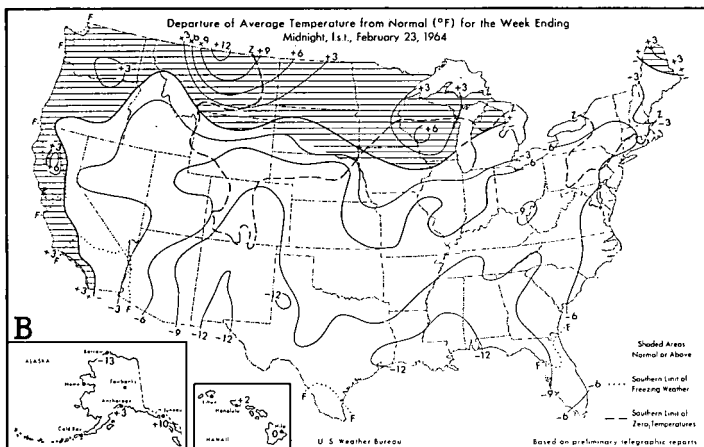
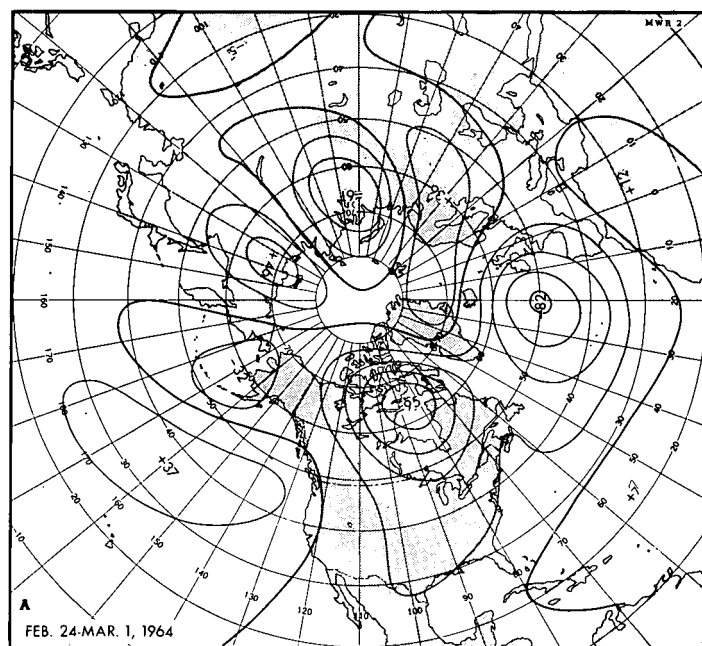
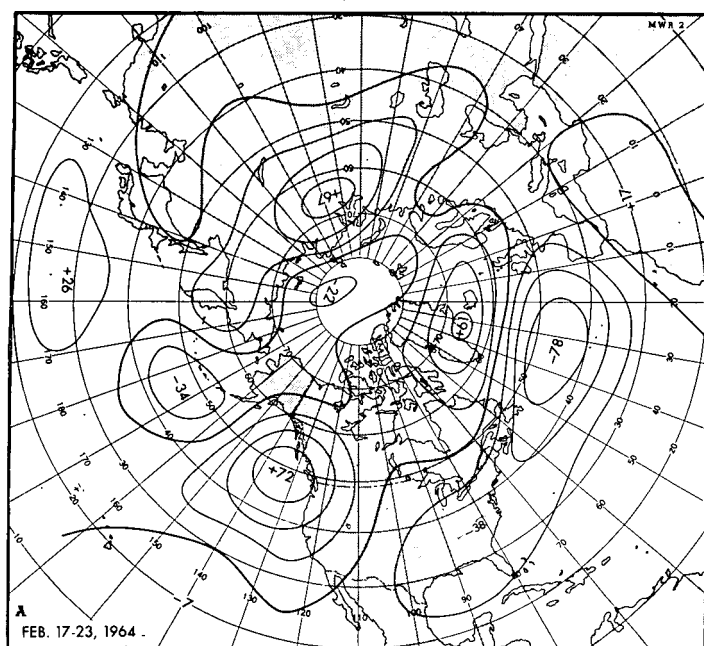


FIGURE 9.—Same as figure 7 for February 17-23, 1964.

FIGURE 10.—Same as figure 7 for February 24-March 1, 1964.

again as pressure increased from the Pacific Northwest across Canada to the Icelandic block (fig. 9A). From the Upper Mississippi Valley westward temperatures continued unseasonably high, and cold weather persisted in the rest of the country (fig. 9B). On February 18-19 a deep

coastal storm brought 6- to 7-in. snows to Ohio, Virginia, the mid-Atlantic States, and southern New England. In Pennsylvania the snow was even deeper, ranging from 13 in. to a near-record 20.8 in. at Harrisburg. Meanwhile another disturbance swept out of Texas on February

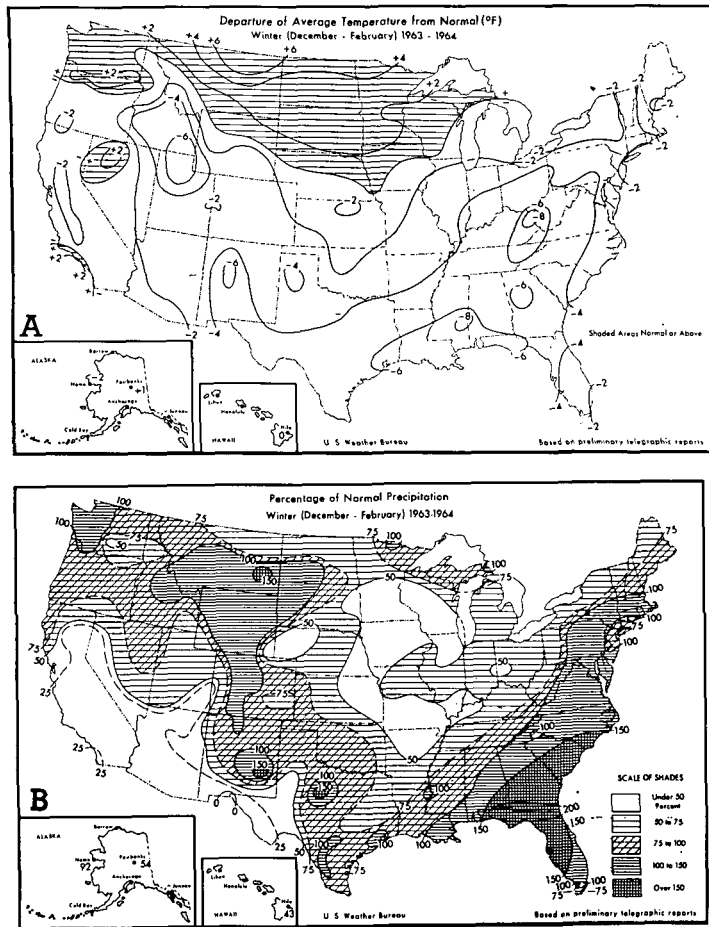


FIGURE 11.—(A) Temperature departure from normal ($^{\circ}\text{F}$.) and (B) percentage of normal precipitation, for winter 1963-64. (From [3])

20-22, after leaving 4-8 in. of snow in parts of New Mexico and Texas, and spread heavy rain along the Gulf coast (fig. 9C). The lowest temperatures of the month interrupted the mild weather in the North Central States on February 23-24, and the cold then spread across the Northeast.

During the last week a sharp drop in heights over Canada at 700 mb. (fig. 10A) was accompanied by another dramatic recovery in the zonal index to well above normal speeds (fig. 5). It was again mild only in the North Central States and continued very cold in the remainder of the country (fig. 10B). On February 24-25 a Gulf disturbance produced heavy rains in the South (fig. 10C), while another storm was plunging southeastward in the Rockies accompanied by heavy snow in parts of Montana, Colorado, and Wyoming, where Lander received 9.3 in. This disturbance later brought excessive rains to parts of Georgia and northern Florida on the 28th and heavy snow ranging from 5 in. in Tennessee and Virginia to 11.6 in. at Nantucket, Mass. on February 28-29.

6. WINTER 1963-64

The average weather for the winter (December, January, and February) was quite similar to that of February. The anomaly of the winter circulation (not shown) was also very similar to that of the February circulation (fig. 2). December 1963 was probably the coldest month of that name on record, with the possible exception of the historic December of 1909, as a result of the extreme amplitude of the North American ridge in northwestern Canada [2]. Moderation of the cold occurred in January and February, especially in the North Central States, as pressure lowered over the Yukon and a westerly regime developed there.

It was much colder this winter in the Far West than last winter (1962-63), but much warmer in the North Central States (fig. 11A). In the South, however, this winter was about as severe as the previous winter and even exceeded the latter in some areas, notably at El Paso and Port Arthur, Tex., Vicksburg, Miss., and New Orleans, La., where it was the coldest on record.

On the basis of average winter temperatures at 50 cities representing all sections of the country except Alaska and Hawaii, this winter ranked only slightly warmer than the winter of 1962-63 which was one of the coldest on record. The winter of 1963-64 was the third consecutive cold winter countrywide and the seventh consecutive winter colder than normal in the East and/or South. Such persistence of cold weather appears to have had no precedent in the available records countrywide, although the East and South had similar persistence at the beginning of this century.

It was a relatively dry winter west of the Appalachians, including most of the Mississippi Valley (fig. 11B), similar to the autumn of 1963 and the previous winter. In parts of the Upper Mississippi Valley, Great Lakes Region, and Ohio Valley, drought has persisted for as long as 2 yr. or more. The water level in Lake Michigan was reported to be the lowest on record at the end of February.

In the Far West it was the driest winter on record in many areas, notably near El Paso, Tex., and Burbank and Red Bluff, Calif., and it was the second driest at Phoenix, Ariz.

East of the Appalachians and near the Gulf Coast it was a wet winter, and in northern Florida Jacksonville recorded 17.44 in. for the wettest winter on record.

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